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FOREST PEST MANAGEMENT

BIOLOGICAL EVALUATION R2-95-4

PEST CONDITIONS IN AMPHITHEATER, SILVERJACK, BEAVER LAKE AND BIG CIMARRON CAMPGROUNDS, OURAY RANGER DISTRICT, UNCOMPAHGRE NATIONAL FOREST, COLORADO

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Forest Pest Management
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EXPERIMENT STATION

EXECUTIVE SUMMARY

At the request of Maureen McCormack of the Ouray Ranger District, Grand Mesa, Uncompahgre and Gunnison National Forests, walk-through evaluations of insect, disease, and hazard tree conditions were performed in August 1991, in Silverjack, Beaver Lake, Big Cimarron and Amphitheater Campgrounds. Because of the conditions in Amphitheater Campground, the walk-through evaluations were followed up with an extensive forest health survey. The campground survey was divided into two portions: an inside-campground survey and an outside-campground survey. An intensive walk-through assessment was also made to map the locations of root disease centers both within the campground and in the areas proposed for campground expansion. In 1995, Amphitheater and Beaver Lake campgrounds were again visited, and walk-through examinations were performed.

With the exception of a few hazard tree situations, no major insect or disease problems were identified at Silverjack, Beaver Lake and Big Cimarron Campgrounds. However, the presence of aspen as a major stand component at Silverjack Campground will likely result in increased loss to mortality and hazard tree problems in the future. At Beaver Lake and Big Cimarron Campgrounds, increased use with the proposed installation of new facilities to promote picnicking and fishing may also contribute to additional hazard tree situations. In 1995, two spruce failed at Beaver Lake Campground. Prediction of the failures would have been difficult at best.

The results of the inside- and outside-campground surveys performed at Amphitheater Campground are presented in Appendix E. Hazard levels were found to be moderate. Defoliation by western spruce budworm (Choristoneura occidentalis) was identified as a major insect problem in the white firs throughout the campground. Numerous root disease infection centers, caused by the fungal pathogen Heterobasidion annosum (annosus root disease), were found in the white fir stand to the east of the campground, in an area that is under consideration for campground expansion. Locations of the root disease infection centers are mapped and presented in Appendix D.

During the 1995 visit to Amphitheater Campground, it became evident that the current budworm outbreak is subsiding. However, additional defoliation and mortality may be expected before the budworm populations return to endemic levels. No additional mortality due to annosus root disease was noted.

Several management alternatives are presented for consideration. A combination of management activities are recommended. Institution of an annual hazard tree evaluation program, as outlined by Forest Service Manual direction is recommended for all campgrounds. Because of the recent tree failures at Beaver Lake Campground, more stringent standards of hazard tree identification and removal will need to be implemented. At Silverjack Campground, selected aspen removals, coupled with the planting of coniferous species, would help alleviate anticipated hazard tree and mortality problems.

To address the spruce budworm infestation at Amphitheater Campground, thinning, to change stand structure to a less dense, more even-aged composition, is recommended. Additional groups of trees may also be removed to create scenic vistas of the surrounding mountains and the town of Ouray. Planting with pine species to further break up the budworm-susceptible white fir stand component is also highly recommended. Because of the episodic nature of spruce budworm outbreaks, these measures will need to be implemented regardless of the fact that the pest populations are currently declining. Sprays of Bacillus thuringiensis ("Bt") may also be considered to further reduce budworm populations and protect the remaining white firs.

To alleviate the annosus root disease problem and better insure camper safety, removal of all visibly infected white firs and all white firs within 30-50 feet of any visibly infected trees or stumps will be necessary. In the disease and buffer zones, removal of all stumps to eliminate buried inoculum and replanting with pine species to establish non-host species is also desirable. Because H. annosum has the ability to spread by aerial-borne spores and infect wounds and freshly cut stump surfaces, additional measures will need to be taken to prevent the spread of the disease to the main campground areas. Various methods to prevent infection of the stumps that will be created by the thinning are suggested, differing in cost and effectiveness. These include: (1) removal of all stumps created by the thinning; (2) grinding of stumps to the ground line and treating with borax; and (3) treatment of freshly cut stump surfaces with borax. Although the effectiveness of measures (2) and (3) are largely undocumented, because of the impacts on the soil and costs involved with stump removal, a combination of the latter two measures are recommended. Registration of "Sporax" (the commercial formulation of borax) for use in the state of Colorado will be necessary before these measures may be implemented. Monitoring of the effectiveness of the root disease treatments is essential. The Forest Health Management personnel of the Gunnison Service Center is available to assist in this effort.

To better gain public acceptance and understanding of the various vegetation management actions, opportunities for interpretation should be explored and implemented in all of the campgrounds. Suggested options include placement of signs in the campgrounds, installation of interpretive nature trails, and involving the campground hosts in the interpretive efforts. Public involvement in the replanting effort is also encouraged.

Key to the coordination of the above activities is the development of a vegetation management plan for the campgrounds detailing specific treatment plans and activities, as well as a timeline for their implementation. Development and implementation of the vegetation management plan should involve both the timber and recreation staffs of the Ouray Ranger District. The Forest Health Management specialists at the Gunnison Service Center are available to provide technical guidance and support.

INTRODUCTION

Maintenance of forest health in developed recreation areas has increasingly become a focus of attention in the Rocky Mountain Region. Key to this maintenance is the accurate estimation of the incidence, distribution, and severity of the various disease and insect problems commonly encountered in campground areas. By identifying incidence, distribution, and severity, land managers may identify the campgrounds and areas within the campgrounds where pest suppression measures are most urgently needed, and may gain a better understanding of which control measures are most appropriate for a given situation.

At the request of Maureen McCormack of the Ouray Ranger District, Grand Mesa, Uncompahgre and Gunnison National Forests, walk-through evaluations of forest health were performed in August 1991, by personnel from the Gunnison and Lakewood Service Centers. Insect, disease, and hazard tree conditions in Silverjack, Beaver Lake, Big Cimarron, and Amphitheater Campgrounds were evaluated in the initial visit. Because of the conditions encountered in Amphitheater Campground, overlooking the town of Ouray, the walk-through evaluation was followed up with an extensive forest health survey. In 1995, additional walk-through evaluations at Amphitheater and Beaver Lake Campgrounds were again conducted. The following biological evaluation reports on the conditions found at all of the campgrounds, but concentrates on Amphitheater Campground.

OBJECTIVES

Through the years, various survey techniques have been employed to evaluate hazard trees (Johnson 1981; Sharon and Hubbard 1985), dwarf mistletoe (Hawksworth 1977; Johnson, Hawksworth and Drummond 1980), and root diseases (Bloomberg, Cumberbirch and Wallis 1980; Johnson 1984). In 1990, the methodologies of these surveys were combined into a single survey designed to give an integrated view of the overall insect, disease, and hazard tree situation in individual campgrounds (Angwin 1990a, 1990b). The survey method provided an estimation of the extent, distribution, and severity of dwarf mistletoe, root disease, canker, insect, and hazard tree problems both within and immediately surrounding the examined campgrounds. The same method, with minor revisions, was used again in Amphitheater Campground.

METHODS

The survey in Amphitheater Campground was divided into two portions: a inside-campground survey and an outside-campground survey. The inside-campground survey was designed to address forest pest and hazard tree conditions within the boundaries of the campground itself. In contrast, the outside-campground survey assessed conditions in the surrounding stands that could impact the management and implementation of disease suppression measures within the campground. Since the objectives of the two surveys differed, separate techniques were employed in each area. To illustrate the layout of the inside- and

outside-campground plots, a map showing the plot locations at Amphitheater Campground is provided in Appendix A.

Inside-Campground Survey

The design of the inside-campground survey roughly followed that of the aspen mortality survey developed by Hinds (1976) and the tree hazard survey of Johnson (1981). The survey plots were campsite-centered, in order to better assess tree hazard to occupied areas. Every fifth unit before and after a randomly selected campsite was examined (20% sample). A total of six campsites were examined in the campground. Two types of temporary plots were established:

1. Interior Plots (to determine pest conditions within individual campsites) - Using a point located midway between the fire pit and the picnic table as plot center, a 0.05-acre circular plot (26-foot 4-inch radius) was established. All trees over 5" DBH were examined for root disease, dwarf mistletoe, cankers, defect, western spruce budworm, other insect pests, and hazard potential (Appendix B). Trees affected by spruce budworm were rated by estimating separately the percent of current (1991) and old (pre-1991) defoliation. Four estimation classes were used: 0-25% defoliation; 26-50% defoliation; 51-75% defoliation; and 76-100% defoliation. Hazard trees were rated according to the hazard tree method of Johnson, 1981. Whenever the presence of root disease was suspected (as evidenced by chlorotic crowns or an adjacent stand opening), nearby stumps or fallen dead trees were examined for conclusive evidence of root disease (diagnostic basidiocarps or characteristic decay). All live trees within 30' of a fallen tree or stump with conclusive evidence of root disease were also considered to be infected.

2. Inter-Unit Plots (to determine the condition of trees immediately surrounding the camp units) - For each interior plot sampled, an inter-unit plot was also established. Inter-unit plots were located between the current campsite and the previously numbered adjacent campsite, centered on a line between points midway between the fire pit and picnic table of each campsite. Plot size and data recorded were the same as for the interior plots (Appendix B). In addition, for each inter-unit plot, two 1/300-acre circular plots (6-foot 10-inch radius) were established to record regeneration. The centers of the regeneration plots were located 20' to the left and right of the inter-unit plot center, along a line perpendicular to the line joining two campsites. At each regeneration plot, the numbers and species of trees less than 5" DBH were recorded. The numbers of trees of each species less than and greater than 2' tall were also recorded to determine the relative ability of the regeneration to survive overstory removal.

Outside-Campground Survey

The outside-campground survey was designed to assess root disease, dwarf mistletoe, western spruce budworm, and other insect and disease conditions in forest stands immediately surrounding the campgrounds. A modified strip-survey was employed. A single survey strip located

one-half chain from the edge of the campground was run around the campground perimeter. Sample points were established at every two chains along the strip. At each sample point, a 20 BA factor prism determined sample trees. The sample trees were examined for spruce budworm, root disease, dwarf mistletoe, cankers, defect, and other insect pests (Appendix C).

Root Disease Map

In addition to the inside and outside surveys described above, the entire campground was visually assessed to identify the locations and size of root disease centers within and immediately adjacent to the campground. Boundaries of the root disease centers were set by mapping the locations of conclusively identified infected stumps and fallen trees (Appendix D). While the map does not include the infected live trees that lack above-ground symptoms, it may be assumed that any trees within 30 feet of the mapped disease center boundary are also infected with root disease fungi.

RESULTS

1. Silverjack Campground - Vegetation in Silverjack Campground consists mainly of aspen, though smaller components of spruce and Douglas-fir are present. A number of spruce seedlings were planted in the campground a few years ago, but the mortality rate was high. During the 1991 walk-through examination of the campground, no major widespread insect and disease problems were noted. Many aspens, however, showed signs of camper abuse, and a few potential hazard trees were identified. Potential hazard indicators included broken tops, black target canker Ceratocystis fimbriata), and aspen trunk rot (Phellinus tremulae).

2. Beaver Lake Campground - Vegetation at Beaver Lake Campground consists of a mix of spruce, aspen, and Douglas-fir. Maureen McCormack noted that possible future plans for the campground include the installation of an all-access fishing trail around the lake and a day-use area at the far side of lake. As at Silverjack Campground, a few hazard tree problems were identified in 1991 that will warrant further monitoring, but no major insect or disease problems. A few broken tops, probably caused by winter snow loads, were noted in the spruce, as well as an aspen stump with a Ganoderma applanatum basidiocarp, causal agent of white mottled root and butt rot.

In 1995, two spruce failed following a windstorm in the campground. One snapped approximately 6 feet from the ground line, while the other was uprooted. Inspection of the two trees revealed stem and root decay, respectively. However, it was evident that detection of the defects with an increment borer would have been difficult.

3. Big Cimarron Campground - Vegetation at Big Cimarron Campground consists mainly of spruce, aspen, and Douglas-fir. Many young cottonwoods (and some spruce) are present on the approaches to and along the nearby creek where the District plans to install an

all-access fishing boardwalk. While a few of the cottonwoods along the approach to the creek had broken tops, no major insect or disease problems were noted.

4. Amphitheater Campground - The complete results of the insect, disease and hazard tree survey of Amphitheater Campground are listed in Appendix E. Where possible, the data is reported as percent infection or by severity index.

While the majority of the campground is in a white fir stand (with a smaller component of aspen), a large area in the center of the campground consists of brushy gambel oak and choke cherry. Regeneration levels in the white fir/aspen-dominated portion of the campground are low to moderate (100 TPA of white fir, 100 TPA of aspen), while regeneration of the brushy species is high (1700 TPA of gambel oak, 1725 TPA of choke cherry).

Western spruce budworm (Choristoneura occidentalis) was identified as a major insect problem in all areas of Amphitheater Campground. Ninety-two percent of the white firs in the inside-campground survey showed evidence of spruce budworm activity and were, on average, 66% defoliated (current year's defoliation). Immediately outside the campground, spruce budworm conditions were no better. Ninety-seven percent of the trees surveyed were affected, with an average defoliation of 74%.

Annosus root disease of white fir, caused by Heterobasidion annosum, was the second most important pest problem encountered. Although no root diseased trees or stumps were identified in the inside-campground survey, several root disease centers were found outside the campground, particularly in the east side where facilities expansion has been proposed. Locations of the root disease centers are shown in Appendix D.

The average tree hazard rating for Amphitheater Campground was 4.0, a moderate level of hazard. Eight trees were given high hazard ratings. However, four of these trees (white firs) were assigned high hazard ratings due to the presence of dead tops from past budworm attacks. Only 2-3 feet of the tops were dead and the trees did not appear likely to fail in the near future. The remaining four high hazard trees (two with exposed, decayed roots, one with a seven foot-long dead top, and one leaner) were reported to the District for removal.

During the 1995 walk-through examination, it was noted that the budworm activity has declined somewhat from the 1991 levels. However, many firs continue to be defoliated and it is evident that the budworm outbreak is not yet over. No new mortality was noted around the root disease centers.

MANAGEMENT ALTERNATIVES

1. Do Nothing. Under this alternative, the numbers and severity of hazard trees in all of the campgrounds will continue to increase, along with the probabilities of tree failure, property damage, and personal injury. At Silverjack, Beaver Lake, and Big Cimarron Campgrounds, continued camper abuse will have significant impact on the aspens, a thin-barked species that is particularly susceptible to a wide range of cankers and decays. The impact of this camper abuse would likely be felt most heavily at Silverjack Campground, where very few tree species other than aspen are present.

Although budworm populations are currently declining at Amphitheater Campground, additional defoliation of the white fir may be expected to occur, further degrading the aesthetic quality of the recreation area. To date, the annual defoliation has resulted in large numbers of thin-crowned host trees, many of which may be expected to die within the next few years. If the impacts of this outbreak are similar to those observed elsewhere in Colorado, an average of 10-20% of the mature susceptible white firs may die before the budworm population completely returns to endemic levels (Raimo, 1993). Understory host tree mortality may range from 25-75%. In addition, because western spruce budworm outbreaks occur in a cyclical fashion and current stand structure favors the insect pest, it is likely that additional budworm outbreaks will impact the campground in future years.

Without further management, the root disease centers on the east side of the campground may be expected to expand at a rate of approximately 1 foot per year (Shaw et. al. 1989). In addition, new infection centers may become established throughout the campground as wind-borne spores land on and colonize tree wounds or freshly cut stump surfaces. Additional hazard to the campers may be expected as a result.

Without addressing the root disease problem, it would be ill-advised to expand the campground into the infested area. Measures to mitigate against the potential hazard would have to be implemented. These measures include removal of footpaths through the area, removal of campsites 1, 2, and 28, placement of a no-parking zone from the trailhead to the northeast corner of the campground (where the road turns between campsites 29 and 30), and installation of signs warning campers of the potential hazard, urging them to stay out during windy days.

2. Reduce Tree Hazard Potential. This alternative involves the implementation in all campgrounds of a program of annual inspections to detect and identify hazard trees. While such a program should be done at all campgrounds, implementation would be particularly important at Silverjack Campground, where the overstory is dominated by aspen, and at Beaver Lake, where two tree failures have recently occurred. The tree hazard evaluation proposed is best accomplished in three steps: identification, documentation, and corrective action. The evaluation is not merely a checkup of tree mortality; identification of hazard trees entails the evaluation of both the probability of failure (tree defect evaluation) and the probability of injury or

damage (target evaluation). An appropriate hazard tree sampling system is described by Johnson (1981). A videotape by Sharon and Steinke (1989), "Tree Health Management: Evaluating Trees For Hazard," is available to help train inspection personnel. In order to reduce liability, complete documentation of all hazard tree inspections is a necessity. Corrective action involves the treatment or removal of hazard trees as soon as possible after an evaluation. Whenever possible, tree removal should be accomplished during the off-season to minimize the impact on recreationists. Treatment of hazard trees (short of removal) may include such treatments as pruning or strengthening of the tree by installation of reinforcing cables or metal rods. Not all defective trees need to be treated or removed; only those whose proximity to a target is such that the risk the tree poses outweighs the benefits it provides. Defective trees that are not removed should be monitored closely, particularly if they are located in areas of intensive use.

3. Remove The Targets. In some cases, the severity of the hazard tree problem and the expense of correcting it is such that closure of the campground or sections of the campground is the only reasonable alternative. With the exception of the closures in the root diseased areas of Amphitheater Campground described above in the "Do Nothing" alternative, we do not believe this is the case in any of the campgrounds we surveyed.

4. Implement Spruce Budworm Control. Under this alternative, measures to control western spruce budworm would be undertaken in Amphitheater Campground. The objectives would be to reduce the current budworm levels in the campground, replace the highly susceptible white firs with less susceptible tree species, and increase the vigor of the remaining susceptible trees. Appropriate management activities may include:

A. Thinning - Damage from western spruce budworm is greatest in dense, multi-storied stands composed entirely of susceptible host trees (true firs, Douglas-fir, and spruce). Such stands have tremendous amounts of foliage biomass and provide the budworm with ample habitat. Intermediate crown layers tend to reduce larval mortality during dispersal, and increase available food. Larval mortality is reduced because the continuous crown cover prevents the larvae, spinning down in search of additional food, from falling to the ground, where they become prey for ants, spiders and other predators. In addition, dense, slower-growing, stressed stands tend to suffer greater budworm damage than fast-growing, healthy stands. This is because foliage quality in the stressed stands is is more favorable to the budworm and tends to promote insect survival.

Thinning from below to remove most of the understory and much of the overstory, creating a more even-aged stand composition, would do much to reduce the impacts of current and future spruce budworm outbreaks. At Amphitheater Campground, approximately 1/4-1/3 of the overstory white firs can easily be removed while continuing to maintain a high degree of shading. Additional groups of trees may also be removed to create scenic vistas of the surrounding

mountains and the town of Ouray. With the exception of a small overlook beyond Campsite 20, such vistas are currently lacking in the campground.

B. Replant With Non-Host Tree Species - To enhance species diversity and provide additional resiliency against future budworm outbreaks, it may be desirable to replant certain areas of the campground with non-budworm-host trees. Ponderosa and lodgepole pine are recommended species. The services of a landscape architect may be used to determine which areas should be planted and which should remain open. While seedlings from a nursery may be used in the replanting effort, suitable planting stock may be obtained from the stands immediately adjacent to the campgrounds and transplanted by use of a tree spade. By using larger (up to 15 feet tall) tree spade stock, shade and screening may be immediately replaced.

C. Treat With Insecticides - The use of insecticides remains the only practical alternative for the immediate reduction of budworm populations in high-value stands. However, direct suppression with insecticides to reduce budworm populations, protect foliage and prevent further damage, is at best a short-term management technique which has no effect on stand susceptibility or vulnerability. Suppression of budworm populations may be expected to last a maximum of 5 years, while reduction of damaging defoliation may last for 3 to 5 years (Telfer, 1983).

Two classes of insecticides are operational- biological (Bacillus thuringiensis, commonly known as "Bt") and chemical (carbaryl or acephate) In areas with high human occupancy, such as campgrounds, Bt is the insecticide of choice.

To obtain maximum reduction of budworm populations, applications of Bt must be carefully timed to larval development and bud flush. The best time to spray is when approximately 20% of the larvae are in the fifth or sixth instars and buds are 85-95% flushed. This "window of opportunity" normally occurs around mid to late-June. In 1995, the cost of Bt and its application (excluding NEPA compliance costs, pre- and post-treatment evaluations, and other administrative/support costs) was estimated at approximately $31-37 per acre (Felix, 1995). As with the application of all aerial sprays, completion of an appropriate level of environmental analysis would be required.

To determine the need for the additional spray treatments, annual evaluations of budworm population levels will be necessary. To determine the potential for an outbreak in the following year, budworm egg mass counts would need to be done in the Fall. If more than 10 egg masses per square meter of foliage sampled are found, then a spray in the next year may be needed. The final decision of whether to spray will be determined the following spring by taking a larval population count just after the new buds have started to break. If fewer than 10 larvae are found per 100 buds, then the spray may be cancelled. If greater than 20 larvae are found, then the spray should commence as planned. Ten to twenty larvae is a

"grey zone," where the decision to spray is optional, depending on the degree of protection desired by the District. The staff of the Gunnison Service Center is available to run the two budworm population surveys and provide technical assistance with the NEPA documentation and spray contracts.

5. Implement Root Disease Control. Under this alternative, steps will be taken to alleviate the root disease situation in the east side of Amphitheater Campground. Appropriate management steps may include:

A. Remove Root-Diseased Trees - One of the ways that Heterobasidion annosum spreads from tree to tree is along root-to-root contacts. Diseased trees often take many years to show above-ground symptoms. Because of these factors, it may be assumed that many healthy looking trees near visibly infected trees and stumps are also infected with the disease. Such trees are susceptible to windthrow, especially in thinned stands. For this reason, it will be necessary not only to remove visibly infected trees, but also remove all white firs within a buffer zone of 30-50 feet from visibly infected trees (50 feet is more desirable).

Following the removals, it will be necessary to keep looking for new infections that were missed in the first round of removals. If additional infected trees are found, all trees and stumps within 30-50 feet will need to be removed. Monitoring for appearance of diseased trees may be incorporated into the District's annual hazard tree evaluations.

B. Prevent Further Underground Spread Of The Fungus - Reestablishment of annosus root disease from the previous stand to the next occurs when the roots of regenerating susceptible trees encounter the roots of previously infected stumps. Since H. annosum has the ability to survive for decades in these infected stumps, management of the disease often includes the removal of all stumps of infected and buffer zone trees.

C. Replant With Tree Species That Are Resistant To The "S-Type" Of H. annosum - Another way to address the problem of the inoculum reservoir present in infected stumps is to replant root disease and buffer zone areas with resistant or non-host tree species. Such plantings create gaps between stumps and susceptible trees and give the fungus time to die out of the residual stumps before spreading to the new stand generation. Research has demonstrated the existence of two biological species of H. annosum, the "S-type" and the "P-type" (Korhonen, 1970). At Amphitheater Campground, the fungus that is present is presumably the S-type, which is found on true firs and giant sequoia, but not on pines (Chase, 1989; Ostrosina, Chase and Cobb, 1992). Ponderosa or lodgepole pine, which are also resistant to budworm, are therefore the recommended species for replacement planting. Again, the use of tree spade stock in addition to seedlings (to more rapidly provide a forested appearance) is recommended. If campground expansion is done, the skills of a landscape architect may help decide which areas should be planted and which should be left open.

D. Prevent Aerial Spread Of The Fungus - In addition to spreading via root contacts, H. annosum has the ability to spread by aerial-borne spores to fresh wounds and newly-cut stumps. These spores are produced by basidiocarps ("conks") that may be found on the inside surfaces of old decayed stumps, on the underside of downed windthrown trees or, less frequently, on the outside surfaces of infected standing trees. In pine plantations, treatment of freshly cut stumps with borax (a dry granular formulation of sodium tetraborate decahydrate) to prevent colonization of the P-type of H. annosum is a commonly used management technique (Kleijunas 1989). The borax product that is currently formulated for this use is called "Sporax" and is manufactured by Wilbur-Ellis, Inc. Although the product is not currently registered for use in Colorado, Wilbur-Ellis has indicated that they are willing to work toward registration if there is a market that will support the costs to get it registered. This treatment effectively prevents spore colonization of pine stump surfaces, but does not prevent entrance of the fungus through wounds or eradicate previously-existing root or stump infections. While the effectiveness of this technique is well documented for the P-type of H. annosum on pines, it is less well established for the S-type on true firs. However, since the treatment is relatively inexpensive, it may be considered as a worthwhile alternative to possibly prevent additional disease spread to new stump surfaces. For maximum effectiveness, all new stumps throughout the campground should be treated. This is particularly important if thinning is initiated to reduce stand susceptibility to western spruce budworm.

Another method to address the problem of stump infection is to grind the stumps to the ground line using a stump-cutter such as is used in urban settings. Again, as with the borax treatments, the effectiveness of this treatment is largely undocumented. It is hypothesized that such a treatment will allow more rapid colonization by fungi that are antagonistic to H. annosum. In addition, stumps treated in this manner will be less visible, which is a definite aesthetic plus in a campground setting. However, in addition to producing an environment favorable to fungal antagonists, stump grinding could also produce an environment that is favorable to the fungal pathogen. Addition of borax to the residuals left at the ground line is therefore recommended to provide additional insurance against further root disease spread.

6. A Combination Of Alternatives 2, 3, 4, And 5. The above alternatives are not mutually exclusive. They are best used in combination to solve specific problems in specific areas.

RECOMMENDATIONS

In campground situations such as those present on the Ouray Ranger District, the main priority for vegetation management is to create and perpetuate a healthy, diverse forest which is visually pleasing and less prone to damage by insects and diseases. The best way to achieve this goal is by applying a variety of management activities to address the hazard tree, insect, and disease situations. Management Alternative 6 is therefore recommended. One specific management activity that is already required (FSM R2 Supp. 93-2331.32) is the institution of an annual hazard tree evaluation and removal program in all of the District's campgrounds. The recent tree failures at Beaver Lake Campground further illustrates the need to actively pursue the implementation of an aggressive hazard tree program. Region 2 Forest Health Management has provided direction and a form to help affect the annual safety and health inspection. Assistance in training hazard evaluation crews is also available from the Forest Health Management specialists at the Gunnison Service Center, as well as from the videos and publications discussed previously. Additional specific recommendations for each of the four campgrounds are:

1. Silverjack Campground - Overall, the health of the forest stands in the campground is good. However, the stands are predominantly composed of aspen, which will likely cause significant hazard problems in the future (Hinds, 1976). A program to remove the older aspens and add a significant component of coniferous species would help to alleviate this problem. An intensive survey to identify the locations, densities, species and age-class distributions would help to identify and prioritize areas for tree removal and replanting. In addition to areas where older aspens predominate, areas with heavy foot traffic and camper densities (where soil compaction and wounding are more of a problem) may be targeted for small patch cuts and planting with conifers. Aspens with conks (indicating the presence of white trunk rot, Phellinus tremulae) or cankers (black target canker, caused by Ceratocystis fimbriata, sooty-bark canker, caused by Cenangium singulare, or Cytospora canker, caused by Cytospora chrysosperma) may also be discriminated against. Douglas-fir (on drier south-facing sites), spruce, white fir, ponderosa pine, and lodgepole pine are recommended replacement species. To enhance transplant survival and provide as rapid a replacement as possible, the trees that are brought in should be as large as possible. Again, tree spade stock collected from nearby forest stands are desirable. Two to zero seedlings of most coniferous tree species found in the Rocky Mountain Region, as well as limited numbers of larger 2-1 and plug 1-1 transplant seedlings are available from the Bessey Nursery. Special production orders may also be made.

2. Beaver Lake Campground - While the overall health of the stands at Beaver Lake Campground appears to be good, the recent tree failures illustrate the need to be particularly thorough while performing future hazard tree evaluations in this area. During future evaluations, the roots and butts of spruce should be carefully examined, and cores should be taken with an increment borer if any possibility of internal decay is detected. Boles of the aspens should

likewise be carefully examined for basidiocarps indicative of white mottled root and butt rot (Ganoderma applanatum). If a tree with the disease is identified within falling distance of a target, it should be removed. Continued monitoring of the spruce trees with broken tops is recommended.

If the handicap fishing access and day-use areas are installed along the lake, new, more intensive hazard tree evaluations will need to be done to reflect the new pattern of use. No further management actions are needed at this time.

3. Big Cimarron Campground - Overall, the spruce, aspen, and Douglas-fir at Big Cimarron Campground are in good condition. However, the changing use patterns that may be expected along with the installation of an all-access fishing trail along the river will require adjustment and intensification of efforts to identify and remove potential hazard trees. Particular attention will need to be given to the trees along the trail that leads to the river and along the boardwalk that will be constructed along the river. Most of trees in these two areas are cottonwoods which, like aspen, are particularly prone to decay. While most of the cottonwoods along the river are young and, at this point, need only to be monitored, a few with broken tops were noted along the approach to the river that should probably be removed.

4. Amphitheater Campground - Because of high occupancy rates, high public visibility and presence of major insect and disease problems, vegetation management at Amphitheater Campground should be given high priority. This should be done even though the budworm populations are currently declining and the campground will undoubtedly have a 100% occupancy rate regardless of the condition of the vegetation. Unless action is taken, additional deterioration of the white fir due to western spruce budworm may be expected as the current outbreak subsides, and the stand will remain highly susceptible to future outbreaks. In addition, the safety hazard due to the annosus root disease will only get worse. Mitigation of the problems may best be made through a combination of Management Alternatives 2, 4, and 5. Specific recommendations are:

A. Reduce Tree Hazard Potential - Because of the high visitorship at the campground, safety conditions must be held to the highest possible standard. Annual hazard tree inspections are a must, and any high hazard trees within falling distance of campsites, roads, parking lots, trails, and permanent structures should be removed. In addition, recognition of the root disease problem in the east side of the campground brings responsibility for action, even if the plans for campground expansion are not implemented. At a minimum, the hazard tree inspections will need to take into account the root disease conditions near the trailhead and campsites 1, 2, and 28. Because above-ground symptoms often do not appear until much of the root system is decayed, fading, chlorotic trees within falling distance of these areas, as well as any standing dead ones, will need to be removed.

B. Implement Spruce Budworm Control - As outlined previously, silvicultural treatment offers the best opportunity to reduce stand susceptibility to additional budworm attacks. Adoption of the thinning and replanting measures discussed under Management Alternative #4, are strongly recommended.

As a management tool, direct suppression (chemical treatment) is only recommended where individual tree values are high, such as in campgrounds, recreation facilities, and administrative sites. Chemical treatments only provide temporary protection to individual trees during outbreaks; they have no effect on long-term stand susceptibility or vulnerability. At Amphitheater Campground, applications of Bt may be warranted so that the life expectancy of the white firs that remain after the thinning treatment may be extended. Since the District would be responsible for producing the NEPA documentation necessary to carry out the Bt applications, it is up to them whether to proceed. If the District expresses an interest in proceeding with the spray treatments, the Gunnison Service Center can provide assistance by performing the egg mass and larvae counts necessary to further determine if the sprays should be done.

C. Implement Root Disease Control - Minimum measures necessary to address the root disease-caused hazard situation are outlined above. Although these measures would provide some degree of protection against root disease-caused tree failures, the probability of additional local and long-distance spread of the disease is such that we strongly suggest implementation of the additional measures outlined in Management Alternative #5. Because the infections are present in moderate-to-heavily trafficked areas, this should be done regardless of the decision on campground expansion. Recommended measures include removal of root-diseased trees, installation of buffer zones, stump removal or treatment, and replanting with resistant tree species. As a first step, however, the Ouray Ranger District, Gunnison Service Center, and the Region 2 Pesticide Coordinator will need to work with Wilbur-Ellis to get Sporax registered for use in Colorado. Different management approaches will be necessary in the disease centers and in the rest of the campground. To address the problem in the disease centers, two major options exist. Each varies in cost and effectiveness:

1. Remove all visibly infected trees and all trees within 30-50 feet of infected trees or stumps. Remove all stumps from the ground and replant infection and buffer zones with disease-resistant tree species such as ponderosa or lodgepole pine. Under this alternative, the reservoir of inoculum present in the stumps is removed from the ground, preventing the infection of any white fir regeneration which may enter the infection or buffer zones.

2. Remove all visibly infected trees and all trees within 30-50 feet of infected trees or stumps. Borax or grind and borax all stumps and replant infection and buffer zones with disease-

resistant tree species such as ponderosa or lodgepole pine. Under this alternative, the buried inoculum remains in the ground, but will die out in approximately 50 years. Although treatment of the stumps will not remove the fungus or prevent underground spread to any white fir that may regenerate in the treatment zones, it will help to prevent further infection of the stumps by aerially disseminated spores.

From a biological point of view, the first alternative is preferable, as it more quickly and completely removes the inoculum sources from the ground.

Outside of the disease centers, the major management focus is to prevent aerial spread of the disease to new areas of the campground. Since a major thinning operation is recommended to address the budworm situation, the risk of spread to the remaining stumps is high. Again, several management options are available which vary in cost and effectiveness. These include:

1. Stump removal throughout the campground - Although this measure would completely eliminate potential disease introduction, implementation would be expensive and would cause extreme soil disturbance.

2. Borax application - This treatment is inexpensive but of undocumented, yet likely effectiveness. Infection via tree wounds will not be prevented. This measure may best be considered as "cheap insurance" against root disease spread to freshly-cut stump surfaces.

3. Stump grinding and boraxing of the residuals - This treatment is relatively expensive and of undocumented effectiveness. While it is hypothesized that grinding and boraxing would allow for more rapid introduction of fungi antagonistic to H. annosum, and would thus be more effective than boraxing alone, this combination of treatments has never been tried.

While complete removal of the stumps created by thinning would be the best possible measure to prevent disease spread, from the standpoint of economics and soil disturbance, it is probably not feasible. Because cost will likely drive the decision on how the stumps are treated, we recommend at a minimum, that all stumps be boraxed, but if economically feasible, some stumps should be ground and boraxed so the effectiveness of this treatment may be tested. Regardless of the control measure(s) that are chosen, the condition of the trees surrounding the removed or treated stumps should be monitored in a systematic way. The Forest Health Management staff of the Gunnison Service Center is available to assist in the development and installation of a systematic sampling and monitoring trial so that the effectiveness of the control measures may be more precisely determined.

5. Additional Recommendations For All Campgrounds

A. Draw Up A Vegetation Management Plan - To better coordinate the recommended activities, a comprehensive vegetation management plan should be drafted. At a minimum, the management plan should cover Amphitheater Campground, but may also include Silverjack, Beaver Lake, Big Cimarron, as well as other campgrounds on the Ouray Ranger District. The plan should include a statement of the goals and objectives for managing the vegetation, a description of specific measures that will be adopted to maintain and enhance the vegetation (including western spruce budworm and annosus root disease management activities at Amphitheater Campground), as well as a timeline for their implementation. Provisions for planting of trees and shrubs and the development of interpretive opportunities may also be included. Both the Timber and Recreation staffs of the Ouray District should be involved in the production and implementation of the vegetation management plan. The Forest Health Management staff of the Gunnison Service Center is available to provide assistance with the technical aspects of the plan. In addition, the Service Center staff can provide several vegetation management plans from other recreation areas in Colorado (Turquoise Lake, Twin Lakes, and Taylor Canyon) for reference. Also available is information on how to apply for suppression funding to contribute toward the preparation of the vegetation management plan, implementation of the insect and disease suppression treatments, and to contribute towards subsequent interpretive efforts. A 3400 letter to the R2 Forest Supervisors, titled "Guidelines For The Use Of FPM Funding For Suppression Of Dwarf Mistletoe In Recreation Areas" (Forest Pest Management, 1990a) and a 2300/3400 letter titled "Vegetation Management In Developed Sites" (Forest Pest Management, 1990b) can provide the initial details. In general, multi-financed projects, combining timber, recreation, and FHM suppression dollars receive the best chance for funding.

B. Develop And Implement Interpretive Opportunities - To give the public a greater understanding of the vegetation management activities in the campgrounds, we recommend that opportunities for interpretation be explored and exploited. Placement of signs in the campgrounds, as well as the development of nature trails provide excellent opportunities for the Forest Service to generate public awareness of what is being done to enhance the health of the forest. Involvement of the campground hosts may also be solicited. Through these efforts, the silvicultural effects of specific insect and disease treatments may be explained and efforts to enhance the long-term vegetative character of the area may be highlighted. In addition, the message that the forest is a dynamic, changing ecosystem, not a static, fixed one may be conveyed. Visitors may also be invited to help with the replanting effort by watering the newly planted trees.

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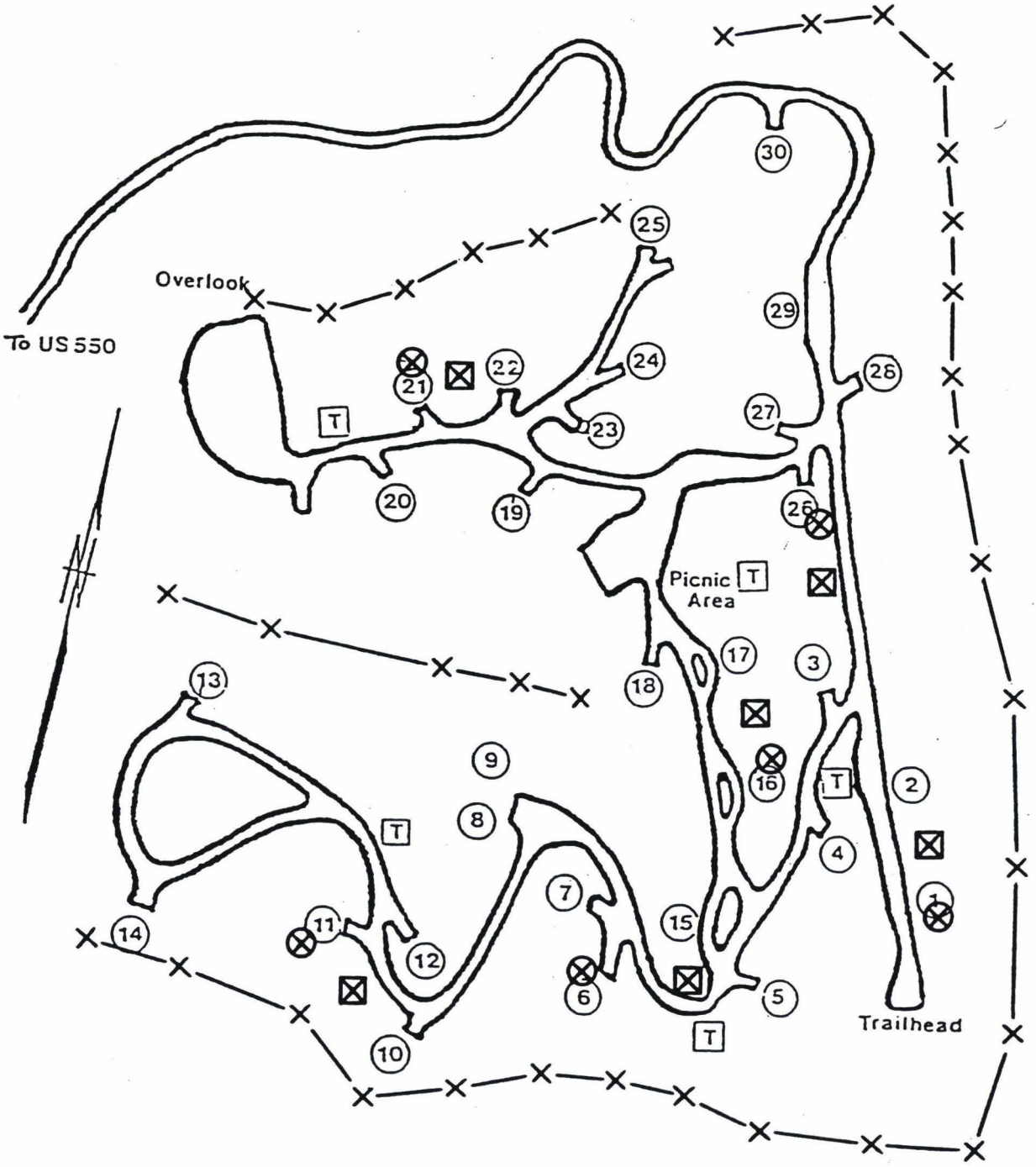
APPENDIX A

Inside- and outside-campground survey plot locations at Amphitheater Campground, Ouray Ranger District, Uncompahgre National Forest.

Within- and Outside- Survey Plot Locations
At Amphitheater Campground.



Within-Campground Survey
(plots established every 5th camp unit)

⊗ - Interior plot center
⊠ - Inter-unit plot center

Outside-Campground Survey
(plot centers 2 chains apart)

× - Outside-campground plot center

APPENDIX B

Inside-campground survey form used to assess insect, disease, and hazard tree conditions at Amphitheater Campground.

INSIDE-CAMPGROUND SURVEY

Forest:_____ District:_____ Campground:_____

Date Of Inspection:_____ Evaluated By:_____

Unit No.:_____

Interior Plot:_____ Inter-Unit Plot:_____ Between Campsites:_____

Habitat Type:_____ Understory Vegetation:_____

Tree No.										
Species										
DBH										
Crown Ratio										
DM Rating										
Hazard Rating										
Root Disease										
Stem Decay										
Internal Decay (Sound/Drill/Core)										
Cankers										
Rust										
Defoliating Insects (% Defoliation)										
Bark Beetles										
Other Insects										
Human Damage (Hacked- S or L)										
Exposed Roots-Solid -Decayed										
Dead Top										
Forked Top-Both Live -One Dead -Both Dead										
Leaning Tree										
Notes										
Regeneration Plots (# trees of each spp. <5" DBH, # trees of each spp. >2', <2' tall) Plot 1. (Left)										
Plot 2. (Right)										

APPENDIX C

Outside-campground survey form used to assess insect, disease, and hazard tree conditions at Amphitheater Campground.

OUTSIDE-CAMPGROUND SURVEY

Forest:_____ District:_____ Campground:_____

Date Of Inspection:_____ Evaluated By:_____

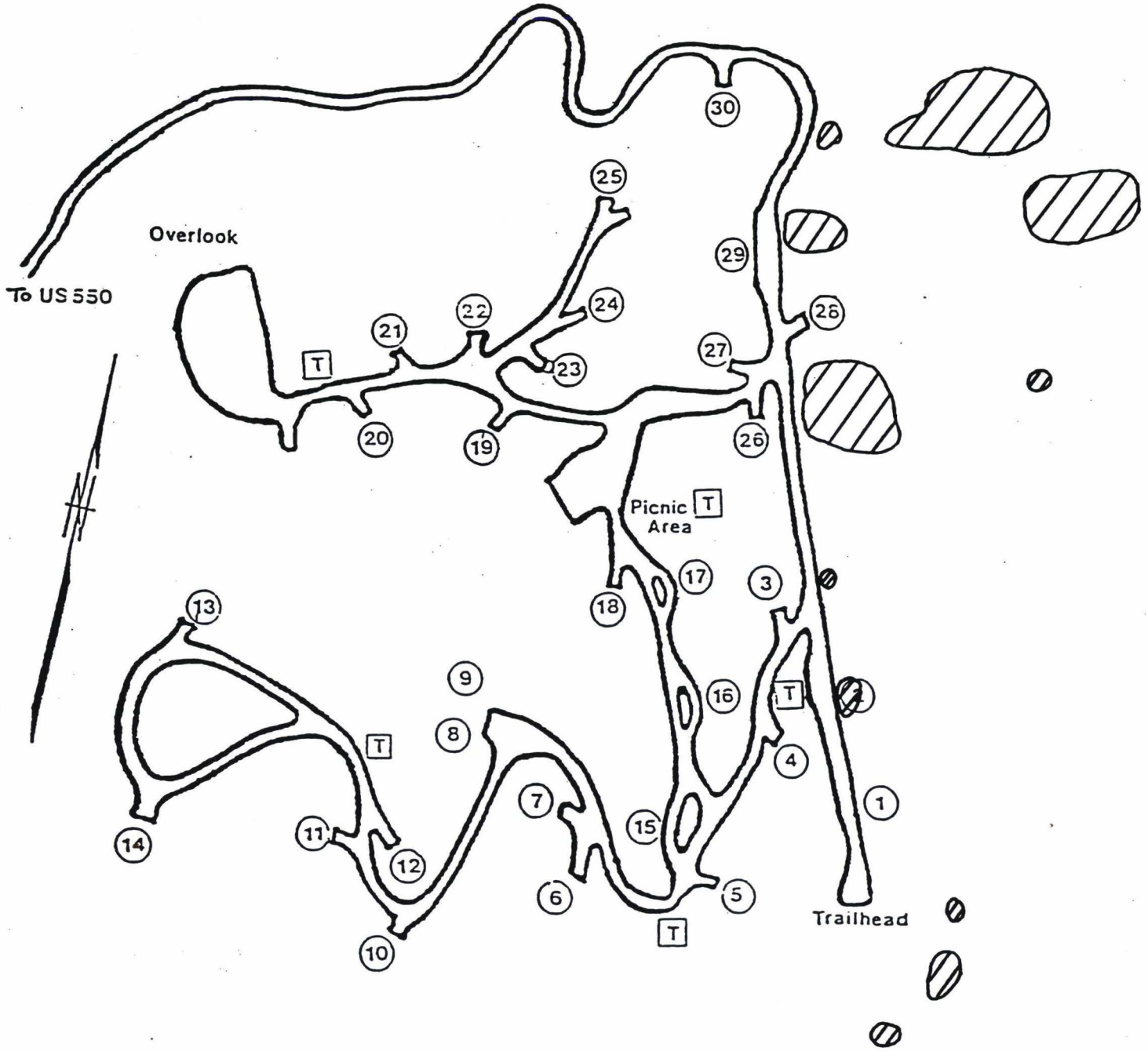
Plot No.:_____ Slope:_____ Aspect:_____

Habitat Type:_____ Understory Vegetation:_____

Tree No.										
Species										
DBH										
Crown Ratio										
DM Rating										
Root Disease										
Stem Decay										
Internal Decay (Sound/Drill/Core)										
Cankers										
Rust										
Defoliating Insects (% Defoliation)										
Bark Beetles										
Other Insects										
Human Damage (Hacked- S or L)										
Exposed Roots-Solid -Decayed										
Dead Top										
Forked Top-Both Live -One Dead -Both Dead										
Leaning Tree										
Notes										

APPENDIX D

Locations of annosus root disease centers at Amphitheater Campground.
(Note: The map shows disease center boundaries as delineated by visibly infected trees and stumps. Because of the underground spread of fungus, it may be assumed that any tree within 30 feet of the indicated disease center boundaries is also infected.)



▨ - Root Disease Infection Center (area bounded by visibly infected trees and stumps)

APPENDIX E

Results of insect, disease, and hazard tree surveys at Amphitheater Campgrounds, Ouray Ranger District, Uncompahgre National Forest.

WF= White fir (Abies concolor)
ASPEN= Quaking aspen (Populus tremuloides)
OAK= Gambel oak (Quercus gambelii)
CHERRY= Choke Cherry (Prunus virginiana)

AMPHITHEATER CAMPGROUND

1. STAND DESCRIPTION

	SPECIES COMP. (%)			BASAL AREA (sq ft/ac)			TREES PER ACRE		
	WF	OAK	TOT	WF	OAK	TOT	WF	OAK	TOT
Inside CG: Interior	100	0	0	86	0	86	73	0	73
Inter-Unit	100	0	0	118	0	0	90	0	90
Pooled	100	0	0	102	0	102	82	0	82
Outside CG:	98	2	---	115	3	118	144	4	148

2. REGENERATION

(Based on inter-unit measurements
25% of plots had no regeneration)

	WHITE FIR	GAMBEL OAK	ASPEN	CHERRY	TOTAL
# Trees Per Acre	100	1700	100	1725	540
% Of Total Regeneration	3	47	3	48	---
# Trees Per Acre >2' Tall	100	400	50	450	390
% Trees Per Acre >2' Tall	10	40	5	45	72
# Trees Per Acre <2' Tall	0	1300	50	1275	150
% Trees Per Acre <2' Tall	0	50	2	49	28

3. TREE HAZARD

	AVERAGE HAZARD RATING (0-3=Low, 4-7=Medium, 8-12=High)			% HAZARD RATING		
	WHITE FIR	GAMBEL OAK	TOTAL	HIGH	MED	LOW
Inside CG: Interior	5.2	----	5.2	1	23	76
Inter-Unit	3.0	----	3.0			
Pooled	4.0	----	4.0	1	20	79
Outside CG:	XXXX	XXX	XXXX	XX	XX	XX

4. SPRUCE BUDWORM INCIDENCE

PERCENT WHITE FIRS AFFECTED BY SPRUCE BUDWORM: CURRENT YEAR'S (1991) DEFOLIATION)

	% WITH 0-25% DEF	% WITH 26-50% DEF	% WITH 51-75% DEF	% WITH 76-100% DEF	AVG. PERCENT DEFOLIATION
Inside CG: Interior	5	23	14	59	69
Inter-Unit	11	15	33	41	63
Pooled	8	18	24	49	66
Outside CG:	3	11	14	71	74

PERCENT WHITE FIRS AFFECTED BY SPRUCE BUDWORM: OLD (PRE-1991) DEFOLIATION)

	% WITH 0-25% DEF	% WITH 26-50% DEF	% WITH 51-75% DEF	% WITH 76-100% DEF	AVG. PERCENT DEFOLIATION
Inside CG: Interior	55	32	14	0	27
Inter-Unit	48	44	7	0	27
Pooled	51	39	10	0	27
Outside CG:	52	31	12	4	29

5. ROOT DISEASE (HETEROBASIDION ANNOSUM) INCIDENCE

	% WHITE FIR WITHIN 30 FEET OF ROOT DISEASE	% WHITE FIR WITH DIAGNOSTIC DECAY
Inside CG: Interior	0	0
Inter-Unit	0	0
Pooled	0	0
Outside CG:	11	4

6. OTHER DISEASES AND INSECTS

	PERCENT WITH STEM DECAY			PERCENT WITH RUST DISEASE			PERCENT WITH BARK BEETLES			PERCENT WITH OTHER INSECTS		
	WF	OAK	TOT	WF	OAK	TOT	WF	OAK	TOT	WF	OAK	TOT
Inside CG:												
Interior	0	0	0	0	0	0	0	0	0	0	0	0
Inter-Unit	0	0	0	0	0	0	0	0	0	0	0	0
Pooled	0	0	0	0	0	0	0	0	0	0	0	0
Outside CG:	0	0	0	0	0	0	0	0	0	0	0	0

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